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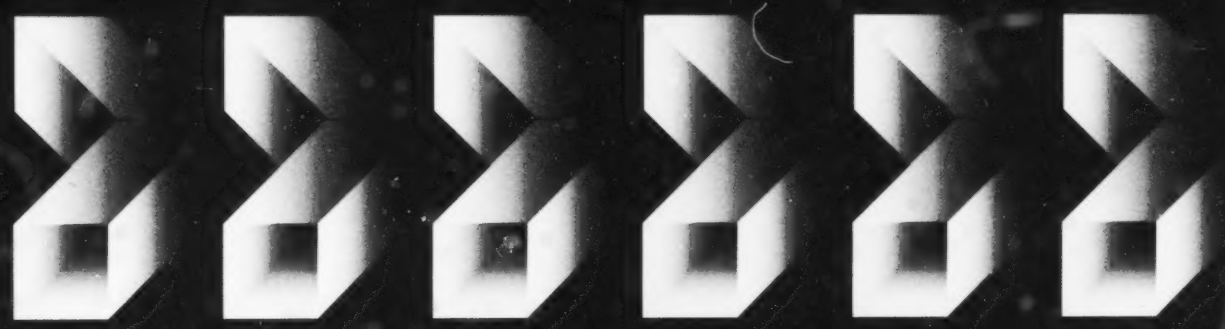

ENVIRONMENTAL UV CASE STUDY: TECHNICAL REPORT #2

EVALUATION OF THE ENVIRONMENTAL HAZARDS PROGRAM

August 1995

Canada

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THE ENVIRONMENTAL UV PROGRAM
A CASE STUDY

by

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Prepared for the
Program Evaluation Division
Health Canada
Contract No. H1021-4-9108

17 March 1995

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NOTE:

This consultant's report was prepared for Program Evaluation Division, Policy and Consultation Branch, Health Canada, as part of the Division's evaluation of the Department's Environmental Hazards Program, under consulting contract H1021-4-9108.

The analysis, conclusions and recommendations found in this consultants' report are those of its authors and are not necessarily shared by the Department of National Health and Welfare.

104-00502/

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1. INTRODUCTION

The purpose of this evaluation is to address several questions, on behalf of the Program Evaluation Division of Health Canada, about the Program carried out by the Radiation and Protection Bureau (RPB) of the Environmental Health Directorate to provide public information on the hazards of exposure to solar ultraviolet (UV) radiation connected with stratospheric ozone depletion. These questions, which are presented in Appendix I, pertain to the scope and progress of the Program, the effectiveness with which it communicates with other government bodies and with the general public, and the use the Program makes of the Health Protection Branch's risk assessment and risk management model.

For the purposes of this report, we have considered that the evaluation period ended on 31 March 1994.[1] The main content of the report is based on documentation received at the start of the project (May 1994), information gathered during interviews conducted during June to August 1994, and additional documentation provided to us in the interview period. We have incorporated review comments on the draft version of the report (which was written in October 1994). Where these comments substantially differed from our original information, we have identified their origin in this final report.

1.1. THE ENVIRONMENTAL UV PROGRAM

An approximate chronology of the launching of RPB's Environmental UV Program is presented in Table 1-1. The Program's origin can be traced to concern about the health effects arising from stratospheric ozone depletion (and perhaps to the fact that Environment Canada quickly put in place an energetic program of its own to provide the public with information about the hazards of overexposure to sunlight). Specific documentation regarding the program's development and rationale was, however, difficult to come by. We do know that, by the early 1990s, Health and Welfare Canada was recognising ozone depletion as a human health hazard [Catley-Carlson (1991);

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1 The end of the fiscal year in which the Request for Proposal (RFP) for the project was sent out.

TABLE 1-1 *Chronology of the "Launch" of Health Canada's Environmental UV Program**

DATE	EVENT
1950s	Atmospheric Environment Service commenced investigating ozone levels in the upper atmosphere as a potential means of developing long-range weather forecasts
1974	Health Canada started becoming concerned about the potential effects of solar UV radiation on the Canadian population
1987	The *Montréal Protocol* on ozone depleting substances (September 1987) was one result of this (and world-wide) concern — Health Canada provided an advisor on UV health issues to the Ministers; agenda heavily driven by Environment Canada.
1989	U.S. EPA report published a "risk assessment" linking stratospheric ozone depletion with increased skin cancer incidence and, by linking this "enhanced risk" with estimates of continued decreases in stratospheric ozone, predicted a "cost" for the expected increase in morbidity and mortality by the year 2040.
1991	Health Canada produced a pamphlet on UV health effects designed to be sent out with family allowance cheques — initiative cancelled through "lack of funds".
1991 (Nov.)	Work commenced on setting up a conference on health effects of UV, primarily "sponsored" by LCDC (to be held in March 1992)
1992 (Feb.)	UNEP report linking 1% decrease in stratospheric ozone with 3% increase in incidence of all skin cancers
	Environment Canada announced "Ozone Watch" program
1992	RPB produced a technical assessment of the UV health question requested by the Director General of the EHD to represent the position of the Federal-Provincial Advisory Committee on Environmental and Occupational Health.

TABLE 1-1 (contd.)

DATE	EVENT
1992 (Mar.)	International meeting of "experts" (Canadian and U.S., mainly, with representatives also from U.K. and N.Z.) dealing with health effects of UV — resulted in a positive response for political action from Ministers of Health and also calls for improved identification on, and standards for, sunscreen products, and standards for UV "protection" from sunglasses (the latter aimed at adequate labelling of products sold on the Canadian market).
1992 (Feb.–Apr.)	NASA report announced unusually high levels of CFCs in upper atmosphere and linked this, by modelling, to reduction in stratospheric ozone levels; on 2 April 1992, Environment Canada convened a meeting of interested experts to consider the implications of this depletion on UV exposure and subsequently conducted focus-group testing of the UV-Index concept; the NASA report, and Environment Canada action, resulted in a "media frenzy" over health effects of UV exposure.
1992 (Mar.)	Money found (~$100K) to publish a booklet — *The Sun, Your Baby and You* — in collaboration with MacLean-Hunter (approx. 2 million booklets eventually distributed).[2]
1992 (May)	Environment Canada launched the UV-Index (arbitrary scale from 0 to 10, loosely based on expected UV insolation at ground level and, *inter alia*, on stratospheric ozone levels).
1992	Series of health-related "messages" developed at RPB for use by Environment Canada in explaining the implications of the various UV Indices.
1992 (June)	Departmental UV program policy developed by RPB — components: public communication, sunscreen efficacy, research.

* Information obtained through interview discussions.

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2 An elaboration of this statement was provided by a reviewer of the draft version of this report who stated, "2 million booklets all distributed with still incoming requests in 1994 (9000); booklet needs to be reprinted".

Bouchard (1991)] and thereby implicitly acknowledging the hazards from solar UV radiation.[3] Such recognition paved the way for the development of programs including public education on solar UV radiation within both Health Canada and Environment Canada.

The environmental UV Program of the Radiation Protection Bureau is a relatively new program with few personnel (part of the lasers and electro-optics unit in the Bureau's Non-ionizing Radiation Section). Its policy falls within part of the mandate of the Lasers and Electro-optics unit, namely, "to assess and manage the risks that may threaten the health of Canadians in the areas of . . . solar light and UV". Within this policy, the goals of the Environmental UV Program are to:

1) increase technical and scientific expertise and credibility on UV radiation effects on humans,

2) reduce short-term and long-term UV effects in the Canadian population by modifying mainly the attitudes of young people towards sunbathing and sun overexposure,

3) help reduce the present mortality due to skin cancer, and

4) test the efficacy of preventive programs.

And it uses three means to achieve these goals: Research, Regulatory Action and Education. [Deslauriers (1994a & b)]

This policy was developed in mid-1992, but the Program still has some of the attributes of an "orphan" program. Its new role is being integrated with the other aspects of the non-ionising-radiation program (e.g., regulation, compliance and laboratory analysis of higher-risk equipment sold on the Canadian market and emitting ultraviolet, visible, or infra-red radiation). Historically RPB has developed expertise with UV radiation from regulating such devices as tanning equipment. Before 1991, its main concern in regards to non-ionising radiation was with radiation produced by sunlamps,

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3 This documentary "evidence", however, was associated with activities under the *Canadian Environmental Protection Act* regarding the "toxicity" of carbon tetrachloride — a target substance under the *Montréal Protocol* on substances that deplete the ozone layer.

which were and are regulated under the *Radiation Emitting Devices Act*. The situation was summarised by one of our respondents:

> Traditionally, action [with regard to UV radiation] at the RPB has involved discharging its duties under the *Radiation Emitting Devices Act* — the sun is not a "radiation-emitting device", so action with regard to UV exposure has to be taken under the general health-protection responsibilities of Health Canada. This required that a different approach be devised, adopted and learned — and this change in approach caused some difficulties.[4]

The Environmental UV Program, therefore, does not fit into the normal scheme of operations of the Non-ionizing Radiation Section (or, indeed, with the Consumer and Clinical Radiation Hazards Division of which this section is part) and appears to be overlooked in some accounts of the Bureau's activities. For example, solar radiation is not mentioned in the Annual Review that forms the preamble to the most recent *Project Area Reviews 1994, Number 04: Non-Ionizing Radiation* [Bly (1994)]; the risk from solar UV is explicitly mentioned only twice in the *Data Collection Report: Environmental Health Directorate*, and one of these references occurs in the same section as the statement, "There is no conclusive evidence that exposure to non-ionizing radiation contributes to any negative health effect" [HPB (1993) p. 85]. Perhaps unsurprisingly, the Program's objectives and its approaches to achieving those objectives are not formally defined in such documents. And, in fact, we took the statements of the Program's policy (quoted in the preceding paragraph) from a set of lecture notes and unpublished documentation provided us during the course of the interviews [Deslauriers (1994a & b)] that we had been provided with during the course of interview discussions.

Despite its ambiguous status within the RPB, the environmental UV radiation Program is evidently growing, to judge from the fact that other recent projects within the Non-ionizing Radiation Section were cancelled or postponed at least in part because higher priorities were given to solar radiation. [Bly, (1994) pp. C.-9, D.-1]

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4 A clarification of this quote was provided by a reviewer of the draft version of this report who stated:

"Traditionally, the mandate of the Radiation Protection Bureau, with regard to UV radiation, applied to equipment and was promulgated under the *Radiation Emitting Devices Act* — the sun is not a "radiation-emitting device", so action with regard to UV exposure has to be taken under the more general health-protection responsibilities of Health Canada. This required that a different approach be devised, adopted and learned — and this change in approach caused some difficulties."

1.2. APPROACH ADOPTED

In conducting this case study, we obtained information from two main sources — structured interviews with federal-government employees associated with the Program[5] and a review of pertinent documentation. Our review of documents for this case study was limited to material supplied by the RPB and the Program Evaluation Division at the beginning of the study, and documents identified or provided as a result of the interviews. We did not undertake an independent literature search. The documents that formed part of this review are listed in Appendix II.

After familiarizing ourselves with the general aspects of the Program through a preliminary perusal of the supplied documentation, a series of interviews was conducted. The initial step involved a short meeting with the contact person identified by the Program Evaluation Division for this case study.[6] During this meeting we briefly outlined the purpose of the case study and asked for names of individuals who would be able to help in answering the evaluation questions (presented in Appendix I). One of these individuals suggested a further person to contact and in this way a total of five people, including the original contact person, were identified, and face-to-face interviews were carried out.

Two team members were used in all but one of the face-to-face interviews (for the other interview, scheduling constraints meant that only one team member was available) and, prior to each interview, interviewees were sent outlines of the topics we wished to discuss. After each interview, a point-form account of the session was prepared and sent to the interviewee for comment. Comments (if any) from the interviewees were incorporated in the interview accounts and these accounts then formed one of the bases from which we answered the project's evaluation questions.

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5 It was not part of our mandate to contact individuals outside the federal government.

6 Dr. Yvon Deslauriers, Head, Electro-Optics Unit, Non-ionizing Radiation Section, Radiation Protection Bureau, Environmental Health Directorate.

The topics discussed during the interviews fell into three categories — the Program in general; the origin, scientific basis, and purpose of the UV-Index™; and, because it formed a major part of the evaluation questions we had been asked to address, communications with the public and with other agencies — and these are summarised in Table 1-2. The responses to the interviews, as modified by comments received from the interviewees, are summarised in Appendix III.

1.3 THE ROLE OF SCIENCE

Determining the effects of human exposure to environmental UV radiation encompasses a range of problems. There are, for example:

- the uncertainties in the relationship between the tropospheric emissions of "ozone-depleting chemicals" (as defined in the *Montréal Protocol*) and the actual depletion of stratospheric ozone — uncertainties that arise from our current limited understanding of tropospheric and stratospheric photochemistry;
- the rudimentary understanding of the mechanisms of dermatological carcinogenesis; and
- the extent of human exposure — an aspect that depends on essentially unquantifiable factors relating to personal behaviour and lifestyle.

As a result, the scientific uncertainties associated with identifying and quantifying causal linkages between exposure to solar radiation and adverse health effects are enormous. This fact should be kept in mind when trying to judge the success of a program aimed at reducing the impact of effects of environmental UV exposure on the Canadian population.

Science imposes an analytical rigour which provides a foundation and a framework upon which to base solutions. Properly applied, science makes explicit the gaps in information and requires that, in reaching a given conclusion, one not only identifies the gaps but also explain how they are to be bridged. We caution, however, that the science used must be "honest science". There is nothing to be gained by masking decisions made on the basis of non-scientific considerations by invoking "science" as the rationale, and much to be lost. Foremost, perhaps, is the diminished credibility that an otherwise perfectly reasonable decision would have when (as inevitably it must be) the

TABLE 1-2 *Topics Discussed During the Interviews**

- THE UV INDEX AND THE ENVIRONMENTAL UV PROGRAM
- THE RELATIONSHIP OF THE UV INDEX TO HUMAN HEALTH
- EFFECTIVENESS OF THE ENVIRONMENTAL UV PROGRAM AND UV-INDEX INITIATIVES
- THE LEVEL OF RISK ASSOCIATED WITH UV EXPOSURE
- THE ENVIRONMENTAL UV PROGRAM'S COMMUNICATIONS WITH "CLIENT" GROUPS
- SUCCESSES AND PROBLEMS ENCOUNTERED BY THE ENVIRONMENTAL UV PROGRAM

* A summary of the responses is presented in Appendix III.

masking is spotted. If something cannot reasonably be answered by scientific explanation then one should say so and acknowledge that other means have to be used to develop the conclusion.

The Environmental UV Program is a program based on science, and we would argue that it should be encouraged to continue to operate in this fashion. Only in this way can priorities be assigned so that the limited resources available to the Program are used most effectively and, furthermore, a scientific approach offers the prospect that questions on the Program's real effectiveness can be eventually answered.

2. FINDINGS

Our findings in this study are presented under four broad headings: the scope of the problem, possibilities for risk-assessment/risk-management, the nature and extent of communications, with the public and with other agencies, and the role played by scientific research in the Program. In much of our discussion, communication, as a major activity within the Program, and as a means of risk management, forms a common thread. Moreover, communication is the major component of the evaluation questions we have been asked to address.

2.1 LEVEL AND SEVERITY OF RISK

The hazards to human health, from overexposure to solar ultraviolet radiation are reasonably well documented qualitatively: they consist of melanomas and other less serious cancers, immune system depression, skin aging, sunburn, pigmentation, phototoxicity and photo-allergy, and possible damage to the lens or cornea of the eye. Of these, cancers are among the best understood and (in the case of melanoma) probably most serious; they are also the only health effect specifically mentioned in the long-term goal for the UV Program. More than 55,000 new skin cancers are reported per year in Canada [Anon. (1993b)], of which a few percent are melanomas; malignant melanomas are responsible for a few hundred deaths per year [Deslauriers (1994a)].[7] There are data that show that the incidence of melanoma skin cancer (in terms of cases per 100,000 population) increased steadily in Canada over the period 1970 to 1987, as did the mortality (although more slowly) [Deslauriers (1994a)]. These data suggest that the "cure rate" for melanoma skin cancer improved by about 30 percent in the same period. As was suggested during interview discussions, part of the increase in melanoma incidence may have been due to improved (and earlier) diagnosis — a possible result of improved awareness among the public and dermatologists alike — which, in turn, could account for an improved cure rate.

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7 An elaboration of this statement was provided by a reviewer of the draft version of this report who stated, "an estimated 3150 new cases of melanoma will occur in 1994; malignant melanomas will be responsible for 580 deaths in 1994".

What is far less clear, however, is the relationship between the incidence of melanomas (and other skin cancers) and measures of UV exposure such as the UV-Index™ or depletion of stratospheric ozone. In order to derive such correlations it would be necessary to have a series of UV exposure data that extended over a considerable period. This is, of course, not possible for the UV-Index™ (which has almost completed its third year) and we were not made aware of any other applicable data that could be used. In addition, it must be realised that melanoma skin cancer has a considerable latency period (decades) and, therefore, to interpret even the somewhat limited time series of melanoma incidence in Canada of which we are aware it would be necessary to have exposure measurements stretching back to the 1940s. Compounding these problems is the probability that UV exposure among Canadians may have been influenced by changing attitudes to, and opportunities for, sun tanning and that such exposure may be occurring in locations to which Canadian exposure data do not apply.

To put the current situation in perspective, the incidence of melanoma skin cancer may be comparable to the incidence of cancer attributable to natural background ionising radiation, but as indicated by one of our respondents, the total annual incidence of skin cancer in Canada is much greater than the incidence of cancers attributable to natural background ionising radiation:

> The effects (non-specific cancers) and dose response relationships are known for ionizing radiation and, assuming a linear extrapolation model, estimates of cancers from background natural ionizing radiation could range from a few to a couple of thousand per year. This estimate is much lower than the approximately 50,000 new skin cancers per year.

With numbers like these, anything that can be done to reduce the incidence of skin cancers (by reducing population exposure to UV, for example) is likely to benefit a significant number of Canadians.

2.2 RISK ASSESSMENT AND RISK MANAGEMENT

One of the evaluation questions we were asked to address in this project concerned the use of the Health Protection Branch's risk assessment/risk management model.

viz,

> Q1. Do these case studies suggest a need for specific changes or improvements to the way Environmental Health Directorate uses the HPB Risk Assessment/Risk Management framework in planning and conducting its operations? Are there factors that must be addressed which fall outside of the HPB framework?

And there was this ancillary requirement:

> The case study shall include an estimation of the number of persons potentially exposed each year to health risks from ultraviolet light connected with stratospheric ozone depletion, the level of health risk, the severity of that risk, and the effectiveness of the program's activities in this area.

As was pointed out in our original proposal, the resources made available to the project were not sufficient to make, *a priori*, the risk analysis implied above. We therefore stated that we would have to rely on work carried out within the Program to report such an estimation.

Risk analysis is the first phase of the risk assessment stage of the Health Protection Branch's risk assessment/risk management model. We were not, however, provided with any documentation of such risk analysis and therefore cannot comment on the questions in Q1. Rather, we shall explore, in this section, the major difficulties associated with applying the risk assessment/risk management framework.

The hazards of exposure to UV radiation have, as mentioned in the previous section, been identified. But the present state of knowledge is inadequate to establish anything like a dose-response curve that would usefully relate human exposure to (for example) the incidence of melanoma [Council on Scientific Affairs (1989)]; there are great individual differences in susceptibility, and the mechanisms of carcinogenesis are not understood. For effects other than melanoma, some of the problems are greater: other types of skin cancer are not registered with the Laboratory Centre for Disease Control (so that data on them would have to be obtained from "private sources" such as the Canadian Dermatological Association and would therefore not be independently verifiable); moreover, reporting practices for non-melanoma skin cancers differ from province to province, increasing the uncertainty in the data.

It appears that any attempt at quantitative risk assessment in this area faces considerable difficulty in getting useful raw data, let alone in interpreting them. And, in

fact, a quantitative risk assessment of the effects of exposure to solar UV radiation has not as yet been attempted by the RPB, but a project is proposed that would investigate the relationship between sun exposure in Canadian children and melanoma incidence in adult life [Bly (1994), p. E.-9]; this project would presumably at least provide some of the necessary background to a risk assessment for melanoma.

In dealing with an environmental hazard such as excessive exposure to sunlight, the Program's possible risk-management options are quite limited. Scientific research into the mechanisms and probability of cancer is at an early stage. The scope for regulation is narrow: devising standards for sunglasses and requiring that commercial sunscreen packages display the corresponding Sun Protection Factor are the only regulatory options taken to date [Deslauriers (1994a)]; it is difficult to imagine any other realistic forms of regulation that would be effective. The only really practicable risk-management option is that of public communication, with the aim of changing public behaviour by such means as discouraging sunbathing, encouraging the use of sunscreen and suitable clothing for people who are exposed to the sun, and emphasising that children need particular protection. (Even the regulatory efforts so far employed are mainly communicative in intent.) It worth noting that, to be effective, such a program would have to bring about a public change of attitude that is effective even for people on vacation — when they might be expected to be both seeking the sun and out of reach of such reminders of the risk as the UV-Index™.

Similarly judging the effects of the Program would have to be based on behavioural change or measures of education. Such measures have the advantage that they might well show results in the relatively short term. (In view of the fact that Environment Canada has had an active public communication program dealing with UV risks for a number of years, it might be difficult, however, to establish that any particular program was responsible for any changes in public behaviour.) Health Canada has made a first step towards judging behavioural changes by asking a series of questions in the *Canada Health Monitor* regarding practices associated with exposure to, and protection

from, sunlight [Canada Health Monitor (1994)].[8] The findings showed that only a minority of Canadians (some 27 percent) had a sunburn in the previous year and that almost all (some 96 percent) reported taking precautions (staying out of sunlight, wearing sunscreen, wearing protective clothes, or wearing sunglasses) against overexposure [Overstreet (1994)]. Furthermore, ninety-eight percent of respondents with children reported that their children took some form of precaution.

Assessing the effects of the Program directly from the incidence of UV-related diseases (such as skin cancers) would be difficult, because the greatest effects of exposure to sunlight are produced in childhood or the teens, while the associated cancers typically do not manifest themselves until the middle or late years of life. Even if the Program succeeded in immediately and drastically reducing the amount of solar UV the typical Canadian was exposed to, it would probably be several decades before any effect on skin-cancer incidences could be seen.

2.3 COMMUNICATIONS

The extent and effectiveness with which the Project has communicated with both other government bodies and the public are the subject of questions this project is to address, and such communications have in fact formed a major part of the Program's activities to date. Many of these activities have been carried out in connection with the UV-Index™ program of Environment Canada, and therefore we begin by sketching the basis of this program.

2.3.1 The UV-Index™

The UV-Index™ is a quantity related to the risk of sunburning that is calculated by Environment Canada as part of its weather forecasting activities, and is included in local daily weather forecasts; its purpose is to increase public awareness of the potential hazards of solar radiation, and uses sunburn as a surrogate hazard for the more serious concerns, such as melanoma. There is little or no written evidence that Health and

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8 There were almost 2500 respondents to this questionnaire which was administered in February 1994 and covered behaviour since April 1993 [Overstreet (1994)] — i.e., the second year of the UV-Index™.

Welfare Canada formally participated in the development of the Index and in the way that it was presented to the public. To quote one of the principal originators of the UV-Index™:

> The strategy for delivering the product [the UV-Index™] and the public education that went with its introduction was developed in consultation with a number of health organizations and the medical community. For example, the Canadian Cancer Society, Canadian Association of Optometrists, Canadian Dermatology Association, Occupational Health and Safety groups, and government health agencies, dermatologists and ophthalmologists all contributed. [O'Toole (undated)]

This quotation (and, indeed, the whole paper from which it was taken) makes no specific reference to a contribution from Health and Welfare Canada.[9]

The UV-Index™ itself is a measure of the solar radiation that reaches the surface of the Earth. It is based on the (calculated) intensity of solar ultraviolet radiation weighted by an "action spectrum" for sunburn (in other words, a measure of how sunburning potential varies with the actual wavelength of ultraviolet radiation); it thus gives a *relative* indication[10] of the likelihood of suffering sunburn (rather than, for example, melanoma). The calculated intensity incorporates such factors as the angle of the sun above the horizon (at local noon) and simple correction factors for cloud or precipitation. It also incorporates the effect of absorption of ultraviolet radiation by stratospheric ozone, the density of which is calculated using meteorological data that have been found to be useful predictors of the thickness of the ozone layer. The resulting number is scaled to give a value that falls in the range 0 to 10 for the intensities of solar

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9 A clarification to this paragraph was provided by a reviewer of the draft version of this report who stated:

"But in fact the whole UV-Index™ program is a spin off of the AES Ozone Watch program because of the strong convictions of Dr. Deslauriers that it is more important to inform Canadians on the total amount of ultraviolet one gets than only the extra amount one gets from ozone depletion. Several meetings and interactions occurred between RPB and AES in the spring of 1992. RPB expertise served in providing basic technical and scientific information on health effects of ultraviolet radiation as well as risk assessment and perception, knowledge on how to communicate this information to a non-scientific public, public education (*HPB Issues*), and training to AES headquarter and regional technical public communication personnel."

10 Individual differences in susceptibility to sunburn, as well as local and temporal variations in the actual amount of solar UV radiation reaching the ground mean that such a relative measure is the most that can be achieved.

ultraviolet radiation that are expected at ground level in Canada. It is quoted to two significant figures — a greater precision than can be justified by the inherent uncertainties in its derivation — so that the values can be seen by the public to change from day to day, and therefore are more likely to be noticed.

2.3.2 Communications with Other Agencies

Particularly in its early stages, the efforts of the RPB concerning exposure to solar radiation were concentrated on providing information and advice to other groups, of which the Atmospheric Environment Service (AES) of Environment Canada was the most important. This group was responsible for developing and publicising the UV-Index™, together with other measures aimed at increasing public awareness of hazards from solar ultraviolet radiation. The role of the RPB was to provide advice (for example, as to the basis on which a suitable UV-Index™ could be constructed).

A further contribution of the RPB was the provision to the AES of a set of risk statements to be provided to the news media in conjunction with the UV-Index™.[11] Other organisations — the Canadian Association of Optometrists, the Canadian Dermatology Association, the Canadian Cancer Society and the Canadian Ophthalmological Society — also contributed to these statements, and the final list prepared by the AES is a combination of phrases from all contributors [Anon. (1993a)]. The list consists of simple, one- or two-sentence "bullets" such as:

- You can burn on a cloudy day. Up to 80% of the sun's rays can penetrate light clouds, mist and fog.
- Exposure to ultraviolet rays is the main cause of skin cancer.
- Eyes do not develop a tolerance to the sun. Wear sunglasses that screen out UV rays.
- Slip on a shirt. Non-sheer clothing is the easiest way to protect your skin.

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[11] A clarification to this sentence was provided by a reviewer of the draft version of this report who stated that two sets of risk statements were developed — one for the summer season and one for winter activities. In addition, another set of short messages aimed at the public and supported with technical information fact sheets, for public communication officers, was provided to Environment Canada Friendly Environment Citizenship Program.

In the RPB's judgement, some of the statements (the recommendation for sunglasses quoted above, for example) may exceed what would be justified on strictly scientific grounds. This possible element of dissatisfaction is academic, however, in light of the fact that the media rarely, if ever, use these statements — a factor that is beyond the control of both the RPB and the AES.

The RPB continues to perform its role of health-advisor to the AES, mainly through consultations by telephone and document review, but also through lectures and presentations. This advice is considered valuable and timely; and such a source of information is essential; otherwise, AES would have to turn to stakeholders, without guarantee that the information provided would be impartial and appropriate for government use.

2.3.3 Communications with the Public

The Program's first major communications with the public were, as we have seen, made indirectly through Environment Canada's UV program. Subsequently, the RPB has made efforts (sometimes in collaboration with other organisations) to communicate with the public directly. Partial motives for this action may be the insufficient use made of the risk statements provided to AES, the desire to ensure that information provided to the public is as accurate as possible, and the opportunity to circumvent pressures to put out overly simplified messages.[12] Two *Issues* papers on skin cancer and the effects of ozone depletion were produced [HPB (1992), HPB (undated)]. A project to produce educational literature on environmental UV for teenagers was deferred "because of prohibitive cost" [Bly (1994) p. D.-8], but was planned for fiscal year 1994-95. But by far the most successful was a small booklet *The Sun, Your Baby and You,* two million copies of which were distributed with a national magazine [Deslauriers (1994a & b)].[13]

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[12] A further motive might be to ensure recognition for the efforts of the RPB, which is not generally mentioned in documentation of the UV-Index™ program (see Section 2.3.1).

[13] Additional information on this point was provided by a reviewer of the draft version of this report who stated that "[A]ccording to the publisher, Maclean-Hunter, the booklet was the most successful initiative of this kind the company had seen".

The Program also provides advice to and co-operates with such organisations as the Canadian Dermatology Association and the Canadian Cancer Society on various public-awareness programs.

In addition to such formal projects, the Program has provided over 150 media interviews in the past two years. It also provides information to the public in response to direct enquiries. It is probably not a coincidence that the number of routine enquiries to the Non-ionizing Radiation Section as a whole, in the fiscal year 1993–4, was almost three times the average number in the fiscal years 1990–91 and 1991–2, before the Environmental UV Program was established and public concern with ozone depletion had risen [Bly (1993, 1994)]. The degree of effort expended by the X-ray and Non-ionising Radiation Sections to deal with such enquiries and with other similar communications is reflected in a comment made in the *Data Collection Report: Environmental Health Directorate*.

> There is an excessive amount of administrative duties, including repetitive evaluations and information requests from all levels of administration. There is also an extremely high and sometimes unmanageable number of requests for information from media and individuals and a high frequency of Ministerial correspondence and briefings. [HPB (1993), p. 57]

The fraction of these various demands imposed on the Environmental UV Program is unclear, but probably appreciable.

Despite the workload, in this activity the RPB is meeting the important need for a disinterested source of information on these matters that is accessible to the public. One such example may be found in a recent article in *The Globe and Mail* that dealt with differences between the UV index newly introduced by U.S. National Weather Service and that used by Environment Canada [Strauss (1994)].

2.4 RESEARCH

Implicitly, a group within Health Canada that is required to provide the public with health-related information about the effects of solar ultraviolet radiation is also required to ensure that such information is both accurate and up-to-date. Given the uncertainties associated with risk assessment of UV exposure, any improvement in understanding the science underlying the etiology of skin cancer and its connections to stratospheric ozone depletion can only render the process of risk management by public

communication more effective. To this extent, therefore, basic research is an important part of the background to the risk management process.

Scientific research is being carried out on the characterisation of the cancer response in mouse skin after UV exposure. Further projects are proposed to characterise the response of DNA in human skin to UV exposure; to isolate cells from human hair follicles and use them as a way of measuring DNA damage; to study the relationship between sun exposure in children and the incidence of melanoma in later life; and to develop and conduct a national survey to measure the public's understanding of UV radiation and its link to human health. These are collaborative initiatives with the University of Ottawa, the Ontario Cancer Foundation, and the University of British Columbia. [Deslauriers (1994b); Bly (1994)]

The latter project might be expected to provide a baseline by which the (collective) success of any future public communication programs could be judged. The other projects, by increasing understanding of the mechanisms of UV damage to skin and of skin carcinogenicity might ultimately contribute to cure or treatment for cancer; in the shorter term, such understanding would probably help develop a foundation on which to base risk estimates for skin cancers.

3. CONCLUDING REMARKS

The number of Canadians demonstrably suffering relatively serious effects from overexposure to environmental UV radiation is substantial (the estimated 50,000 per year diagnosed as suffering from skin cancer). Moreover, on an individual basis, the solution is comparatively easy and of minimal cost. What is considerably less easy, is persuading the population as a whole to take the appropriate measures. The key, as is acknowledged by the Environmental UV Program's goals, is education aimed at modifying public attitudes towards, and behaviour regarding, sunbathing.

There are great uncertainties in the relation between exposure level and risk and, as we have already argued, such uncertainty may be detrimental to an effective program of public education. We were told during this project that stratospheric ozone levels have been measured in Canada since the 1950s. If such data could be compared with more recent skin cancer incidences,[14] then there would be an opportunity to investigate dose-response relationships which, in turn, could be used to convince the public of the effectiveness of behaviour changes.

Until such relationships are available, less direct indicators would have to be used to measure the success of the program. These indicators would be measures of public behaviour and attitude. Health Canada is not the only organization attempting to modify public behaviour with regard to UV exposure. It may be difficult therefore to ascribe any observed behavioral changes to a particular program.

The group within the RPB dealing with the effects of ultraviolet exposure is composed of one professional and one technical inspector, and these individuals also deal with artificial sources of the radiation. We are not in a position to judge whether the two individuals that currently comprise the UV program's personnel are sufficient, but we could not help noticing the singular lack of visibility accorded Health Canada in most public communications concerning UV exposure and health risks. It is a moot point whether this invisibility is detrimental to persuading Canadians to reduce their exposure to UV radiation, but Health Canada may wish to ask itself how the success of the Environmental UV Program is to be judged if the instigating body remains unrecognised by the targets of its activities.

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14 The data for melanoma skin cancer may be the most complete and unambiguous.

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APPENDIX I: Scope of the Environmental UV Program Case Study

The purpose of the study is to evaluate:

> The provision of public information on the hazards of exposure to ultraviolet light connected with stratospheric ozone depletion.
>
> The case study shall also include an estimation of the number of persons potentially exposed each year to health risks from ultraviolet light connected with stratospheric ozone depletion, the level of health risk, the severity of that risk, and the effectiveness of the program's activities in this area.

and to answer the following questions on "the actions taken and advice given by the Environmental Health Directorate" with regards to the hazards of exposure to ultraviolet light connected with stratospheric ozone depletion:

(1) Q7a. EHD provides information and advice to governments, departments, agencies, and others to help them manage the health risks from environmental sources:

   (a) Do client decision makers get timely and needed information from EHD on health risks from environmental sources?

   (b) Does EHD provide the information in a useful format?

   (c) If EHD didn't provide this information and advice, where would these clients turn for information and advice? What would be the consequences if this were to happen?

(2) Q6. How effectively does the program communicate with specific interest groups and with the public about actual public exposure to radiation and chemical hazards, and known health risks from such exposure?

(3) Q1. Do these case studies suggest a need for specific changes or improvements to the way the Environmental Health Directorate uses the HPB Risk Assessment/Risk Management framework in planning and conducting its operations? Are there factors that must be addressed which fall outside of the HPB framework?

It was, however, beyond the mandate of this study to make contact with individuals and organizations that were outside the federal government. (Such contacts are to form another part of the program evaluation.) For the purposes of this project, the "client" referred to above constitutes other federal government departments (notably, the Atmospheric Environment Service of Environment Canada) and the general public.

APPENDIX II: Bibliography Pertinent to the Environmental UV Program Case Study

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APPENDIX III: Summary of Interview Topics and the Responses[15]

INTERVIEWEES: Three individuals from the Radiation Protection Bureau, Health Canada, and two individuals from the Atmospheric Environment Service, Environment Canada.

THE UV INDEX AND THE ENVIRONMENTAL UV PROGRAM:

- The Bureau has been concerned about the potential effects of solar UV radiation on the Canadian population since 1974, but the current program gets its impetus from Environment Canada's concern with the depletion of stratospheric ozone levels (manifested by the 1987 Montréal Protocol agreement to phase out the manufacture and use of ozone-depleting substances).

- Ozone was originally measured by Environment Canada in the 1950s as a possible forecasting tool. Environment Canada's interest in ground-level UV dates from the late 1980s (ca. time of the *Montréal Protocol*).

- The AES has been monitoring ozone levels for more than 20 years and a concern with the decline in these levels has been growing within the AES since 1980. In the 1980s, "Environment" was very important in public opinion, with ozone depletion ranked as the most important aspect. The UV program originated at AES as part of the Green Plan, but was greatly accelerated by a 1992 NASA announcement concerning the effects of stratospheric chlorine on ozone depletion.

- Health Canada was involved in the AES UV program from the beginning, gave presentations on the effects of UV on eyes, immune system and on cancer incidence, and was involved in selecting the McKinley-Diffey action spectrum.

- Other governmental organisations (in the US or Europe) were too far behind Canada in developing a UV program to have been helpful in developing the UV-Index™ initiative. Australia has provided some help with publications ("Slip, Slap, Slop") but does not have a forecasting program.

- At the start of the Environmental UV Program (early 1992), there was a meeting with Environment Canada (at the ADM level) at which it was agreed that the UV Exposure Index would provide a vehicle for encouraging the public to take precautions against over exposure to sunlight. Environment Canada developed and promoted the concept of the Index.

- The UV-Index™ was launched in May 1992 — The UV-Index™ is presented with weather forecasts. The basis for its development comes from the Green Plan and its aim is public communication.

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15 By and large, each bullet corresponds to a response from an interviewee and thus there will be instances of repetition.

- The UV-Index™ is based on the UV intensity at earth's surface, weighted by the McKinley-Diffey action spectrum for sunburn. The maximum level within Canada is ca. 250 mW/m^2; dividing the weighted intensity by 25 gives a scale running from 0 to 10.

- The UV-Index™ is calculated [our emphasis] from the sun angle and the stratospheric ozone column depth, rather than from actual measurements of ground-level UV, which are available in only a dozen locations.

- The ozone column depth is calculated [our emphasis] for individual forecast areas using meteorological parameters and statistical correlations between these parameters and ozone concentrations.

- The ozone column depth and the sun angle give the clear-sky Index, which is reduced where necessary by empirical scaling factors for cloud and precipitation — contribution from stratospheric ozone, ~95%; contribution from ground-level ozone, ~5%.

- The total ozone column depth from which the UV-Index™ is calculated is accurate to ca. 4%; but quoting the UV-Index™ to two significant figures makes it more noticeable to the public, because the value changes from day to day.

- The UV-Index™ is based on sunburn as the effect of concern, but Environment Canada has provided health messages to the media referring to other effects, although the media do not use them. Environment Canada publications on UV are produced jointly with Health Canada (and the Canadian Dermatological Association in one case).

- The Bureau was asked to vet the health messages that were to accompany the Index, but found that some of the ones proposed by Environment Canada suffered from inaccuracy and imprecision — accordingly, RPB developed the set of statements for use with the Index.

- Environment Canada maintains contacts with stakeholders (e.g., Canadian Dermatological Association; Canadian Cancer Society; Vital Technologies [manufacturer of UV instrumentation]). Without Health Canada as the source of information, Environment Canada would have had to turn to stakeholders, without guarantee that the information provided would be impartial and appropriate for government use.

THE RELATIONSHIP OF UV INDEX TO HUMAN HEALTH:

- There are three regions of the UV spectrum — UV-A = 400 to 315 nm; UV-B = 315 to 280 nm; UV-C 280 nm to the "air cut-off" of ~200 nm — that are considered when addressing health effects of UV radiation.

- The UV-B region of concern for induction of skin cancers — the centre of this region (297 nm) corresponds to the half-height of the DNA response to UV. The UV-A is

the region where skin immune-response is depressed. Solar intensity in UV-C region vanishingly small, and is therefore of no real concern for environmental UV exposure.

- There is no direct link (nor is one ever likely to be proven) between the UV-Index and human health beyond a simplistic acknowledgment that the greater the exposure of unprotected skin to sunlight, the greater the risk of developing skin cancer.

EFFECTIVENESS OF THE ENVIRONMENTAL UV PROGRAM AND UV-INDEX INITIATIVES:

- The goal of the RPB's UV program is to promote the well being of Canadians, for example by reducing the incidence of skin cancers among the population.

  For solar UV radiation, the only realistic "tool" available to achieve this goal is one of public education (e.g., the booklet, *The Sun, Your Baby and You*, and media interviews and public presentations given by the Environmental UV Program).

- The publishing house, MacLean-Hunter, commented that the booklet, *The Sun, Your Baby and You*, was the most successful initiative of its kind the company had seen.

- At the end of the first year of operation of the UV-Index, Environment Canada conducted a poll of the Canadian population and found that 88 percent were aware of the UV-Index and that 74 percent of these took appropriate action based on the Index.

- The Environmental UV Program has been a cooperative and professional source of information [to Environment Canada]. It has helped in training, given presentations and provided useful advice, often by telephone and typically to resolve conflicting interpretations of evidence (e.g., on the importance of wearing sunglasses).

- "Indicators" of the success of the Environmental UV Program would only become apparent in 10 to 15 years when changes in the public's behaviour with regard to sun exposure would begin to be observable in morbidity and mortality statistics. In the short term, visual observation of public behaviour can provide some indication of the program's effectiveness — even in these early days of the program, it seems that individuals are wearing hats and covering themselves up more.

THE LEVEL OF RISK ASSOCIATED WITH UV EXPOSURE:

- No health risk assessment has been done by RPB. UNEP model (mentioned above) still in development.

- LCDC's register only records melanomas — approx. 500 (?)[16] melanoma-related deaths per year in Canada.

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16 A clarification of this figure was provided by a reviewer of the draft version of this report who stated that there were an "estimated 580 melanoma-related deaths per year in Canada".

- Incidence of non-melanoma skin cancers only available from "private sources" (e.g., Canadian Dermatological Association) — ~45K non-melanoma skin cancers in 1989; 52K-53K non-melanoma skin cancers in 1992 — and not independently verifiable (reporting practices differ between provinces, therefore difficult to compile skin-cancer data).[17]

- Non-melanoma skin cancers usually found on skin areas normally exposed to sun — face, back of neck, shoulders, hands — melanomas are commonly associated with areas not normally exposed to the sun — trunk, backs of legs.

- There is a great variability in individual susceptibility to skin cancer — skin type, lifestyle factors, etc.

- Among the non-ionizing radiation group, UV is the only form where the hazard is known (but no dose-response and, as mentioned above, no risk assessment) — the hazards of other forms of non-ionizing radiation are not yet identified.

- The effects (non-specific cancers) and dose response relationships are known for ionizing radiation — assuming a linear extrapolation model, cancers from background natural ionizing radiation could range form zero to a couple of thousand per year (cf., ~50K skin cancers).

THE ENVIRONMENTAL UV PROGRAM'S COMMUNICATIONS WITH "CLIENT" GROUPS:

- Environment Canada (AES) and the general public are main "client" groups; certain professional groups (e.g., Canadian Dermatological Association) and environmental groups (e.g. Greenpeace), could be considered minor "clients".

- Close contact maintained with Environment Canada (but, occasionally, there is a need to "put them straight" regarding the limits of what can be said about health effects and UV exposure/ozone depletion); Environment Canada generally pleased with level and quality of advice.

- Purpose of communication with the public — increased awareness of the effects of exposure to UV.

- Considerable increase in requests by the "public" (both general public and interest groups) for information regarding effects of UV exposure. General feeling that the UV-Index™ has led to increased awareness in the population for the need to take precautions against overexposure to sunlight.

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17 A clarification of these figures was provided by a reviewer of the draft version of this report who stated that "LCDC estimates 58,500 new cases of non-melanoma skin cancers for 1994".

- Health Canada developed a booklet, *The Sun, Your Baby and You*, outlining the need for protection against overexposure to sunlight and precautions to take (published in collaboration with MacLean-Hunter).

- The Environmental UV Program provided seminars to Environment Canada staff regarding UV exposure and health.

- The Environmental UV Program provides advice regarding health effects on a continuing basis to Environment Canada.

- In all respects, the advice provided by the Environmental UV Program was pertinent, timely and of high quality. ([The respondent] felt, however, that much of this effort did not receive full support from higher management levels within BRMD.)

- [The respondent] felt that Health Canada's approach to environmental hazards extremely cautious.

SUCCESSES AND PROBLEMS ENCOUNTERED BY THE ENVIRONMENTAL UV PROGRAM:

- The Environmental UV Program at RPB has: 1) succeeded in producing a considerable volume of solid information regarding health effects of UV exposure, and 2) instigated "cutting-edge" research at the molecular level into effects of UV on living organisms — aimed at understanding both the mechanisms of damage and repair which could, eventually, be a major contribution to improving an individual's ability to protect him- or herself.

- Traditionally, action at the RPB has involved discharging its duties under the *Radiation Emitting Devices Act* — the sun is not a "radiation-emitting device, so action with regard to UV exposure has to be taken under the general health-protection responsibilities of Health Canada. This required that a different approach be devised, adopted and learned — and this change in approach caused some difficulties.

- The fact that Health Canada was not directly involved in the development of the UV-Index™ caused some professional difficulties because scientific interpretation was not always applicable to the simple messages Environment Canada wanted delivered with the UV-Index™.

- To maintain public awareness at its present high level as the "novelty" of the UV Exposure Index wears off, other means will be necessary.